Specification for a Test Procedure for Spiral Wound Gaskets

FSA Publication No. GD xxx/2018

Issue xx/xx/2018

ESA Publication No. GD xxx/2018

This document has been presented by:

Fluid Sealing Association

994 Old Eagle School Road #1019

Wayne, PA 19087-1866

+1 610 971 4850

www.fluidsealing.com

European Sealing Association

European Sealing Association
310, Route De La Plagne
Morzine 74110 Haute Savoie
France

Tel +33 (0) 631 941 600

www.europeansealing.com

Founded in 1933, the **FLUID SEALING ASSOCIATION® (FSA)** is an international trade association. Member companies are involved in the production and marketing of a wide range of fluid sealing devices primarily targeted to the industrial market. FSA membership includes a number of companies in Europe and Central and South America, but is most heavily concentrated in North America. FSA members account for a majority of the manufacturing capacity for fluid sealing devices in the Americas market

The **European Sealing Association** is a pan-European organisation, established in 1992 and representing over 80% of the fluid sealing market in Europe. Member Companies are involved in the manufacture, supply and use of sealing materials, crucial components in the safe containment of fluids during processing and use.

Acknowledgements

The FSA and ESA are pleased to recognise the co-operation of the following Member Companies in the preparation of this document. Without their support, this document would not have been possible:

Individuals who have made a particularly significant contribution to this publication include:

Chett Norton	Triangle Fluids Control, ltd.
Phil Mahoney	A.W. Chesterton Co.
Ron Frisard	A.W. Chesterton Co.
Jim Drago	Garlock
Daniel Bisset	WL Gore
Guillermo San Martin	Empack
Matt Wasielewski	Yarmouth Research
Mark Richardson	James Walker
Martin Coulthard	James walker
Frank Herkert	AMTEC
Stephen Woolfenden	Eriks
Henri Azibert	FSA
David Mitchell	ESA

---

requirements of regulations specific to a particular industrial facility. Readers should consult appropriate local, regional, state, national or federal authorities for precise compliance issues.

Table of Contents

Foreword

This specification gives details of a test procedure for spiral wound gaskets to be used to seal pipe and other flanges. It has been prepared by the Gasket Division of the Fluid Sealing Association (FSA) in collaboration with the Gasket Division of the European Sealing Association (ESA) and is approved by these organisations as a suitable method of test.

1. Scope

This specification details a test method for measuring emissions from flanges sealed with spiral wound gaskets. These types of gaskets are generally of the types described in FSA/ESA publication 'Gasket Handbook" when used to seal flanges. It gives guidance on the design of test equipment, standard test parameters and reporting criteria. It does **not** specify performance criteria which should be agreed between supplier and customer but does define 2 leakage classes.

2. References

Attention is drawn to the following documents:

ASME B16.5. Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard

ASME B16.20. Metallic Gaskets for Pipe Flanges: Ring-Joint, Spiral-Wound, and Jacketed

API 622. Type Testing of Process Valve Packing for Fugitive Emission

3. Test apparatus

The test apparatus shall be similar to the typical example shown in Appendix C, Figure 1 & 2, and shall consist of a 3" Class 300# flange, Standard A105 material. The fixture will be enclosed by an aluminium ring that contains emissions within the fixture but allows outside air to be drawn in for the emission measurement device to draw a sample on the outside of the gasket.
There will be connections to pressurize the inside of the gasket and connections for the probe to take measurements.
Clearance between the outside of the flange and the outer ring shall be 1/16 to 1/8 inch (1.5 to 3 mm)
One measuring point, a drilled hole compatible in size with the monitoring equipment shall be used to obtain measurements.
Threaded connections shall be provided for heating element, two thermocouples, a pressure sensing port, and a gas inlet.
Heating elements and insulation as required to maintain temperature.
The flange fixture shall be mounted so the axis of the pipe and flange assembly is horizontal. The measuring shall be at the top of the outer ring. Centering of the containment ring over the flange shall be made by suitable means at the test facility.
Alternative testing fixture can be with hydraulic loading of the gasket between two platens. This does not simulate an actual flange but provides more accurate stress loading of the gasket. (See Appendix E)

4. Pre-Test Procedure

4.1 Inspect the gasket for overall condition. Take photographs of the gasket on each side.

4.2 Measure and record the thickness at four points evenly spaced around the circumference of the gasket.

4.3 Score the outer ring on both sides in the radial direction approximately 90 degrees apart, across the surface of the rings at least .020", 0,5 mm deep starting at a maximum of 1/4 inch (6 mm) from the spiral.

5. Installation

5.1 Loading method: A193 Grade B7 bolts (or threaded rod) shall be used with A194 Grade 2H nuts and ASTM F436 Thru-hardened washers to tighten the flanges and apply the specified load. Thread length should extend beyond the nut. The thread type should be UNC. The bolting pattern shall be a star cross pattern, in the following sequence: 1, 5, 2, 6, 3, 7, 4, and 8. (See Fig. 1.)

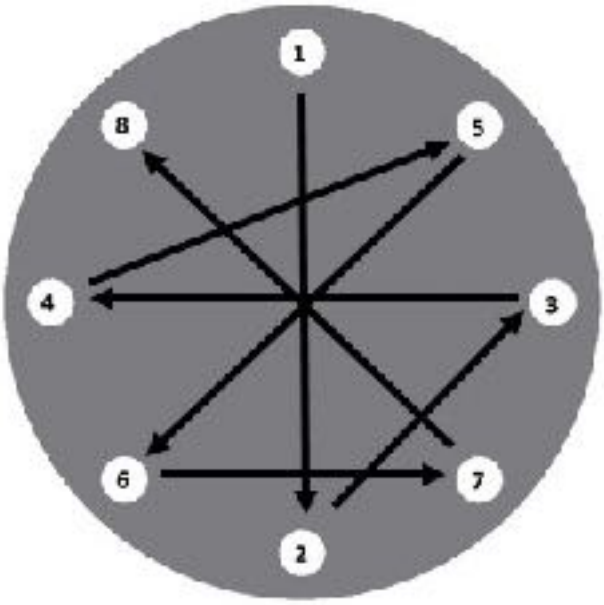


Figure 1. Bolt tightening pattern

5.2 A high grade anti-seize lubricant shall be used for all surface threads, bottom of nut and washer.

5.3 A calibrated torque wrench shall be used.

5.4 New bolts, or rod, nuts, and washers should be used for each test.

5.5 The loading should be sequential starting at 30%, 60% and 100% of required torque, with a final check at 100% of required torque sequentially around the circumference. Conduct successive 360 degrees pass(es) until there is no movement of any of the fasteners.

5.6 The gap between the flanges must be measured at 4 points 90 degrees apart and the variation must not exceed .020" (0,5 mm).

5.7 The torque shall be calculated to achieve the specified load using the following formula: T= KFD.
T: Torque ft.-lb./N.m
K: Nut (Friction) factor
D: Diameter of the bolt ft./m
F: Load lb./N

5.8 The load, torque and anti-seize to be used shall be specified by the manufacturer.

6. Test Conditions

6.1 Temperature. Two test temperatures shall be used. Ambient temperature, (maximum of 100^{0}F, 40^{0}C), and 500^{0}F (260^{0}C).

6.2 Test medium. The test medium shall be methane or helium gas (97% minimum purity).

6.3 Size. Standard 3" 3/4/600 flange dimensions with caps welded on the ends.,

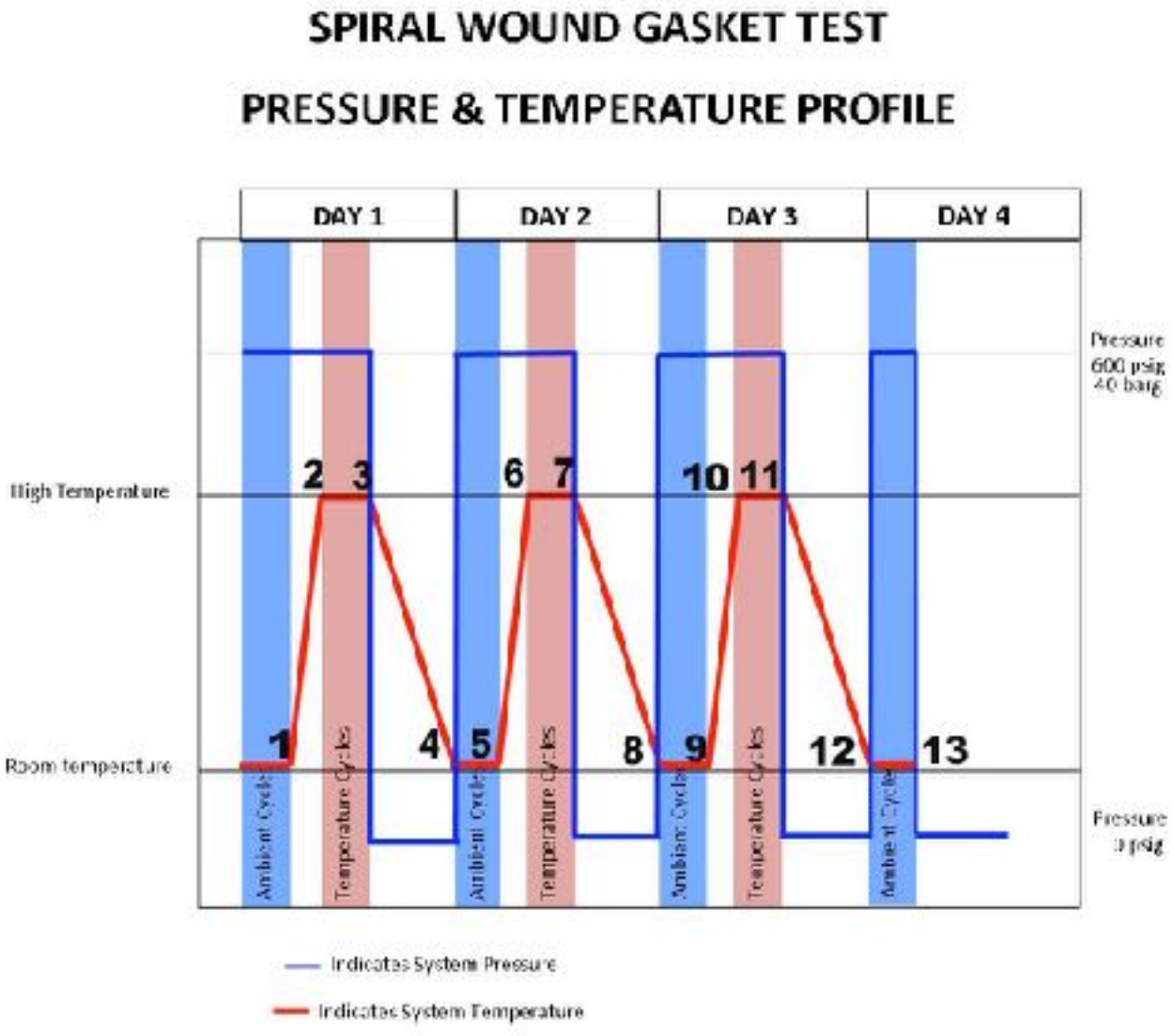
6.4 Dimensions. Per ASME B16.20

6.5 Temperature and Pressure cycles.

1) Ambient temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
2) Release pressure, heat up to 500^{0}F, 260^{0}C, one and one half hour

3) 500^{0}F, 260^{0}C temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
4) Release pressure and cool to ambient temperature 4 to 20 hours
5) Ambient temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
6) Heat up to 500^{0}F, 260^{0}C under pressure, one and one half hour
7) 500^{0}F, 260^{0}C temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
8) Release pressure and cool to ambient temperature 4 to 20 hours
9) Ambient temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
10) Heat up to 500^{0}F, 260^{0}C under pressure, one and one half hour
11) 500^{0}F, 260^{0}C temperature for a duration of 2 hours at a gauge pressure of 41 bar, 600 psig
12) Release pressure and cool to ambient temperature 4 to 20 hours
13) Ambient temperature for a duration of 2 hours at 40 a gauge pressure of 41 bar, 600 psig

Pressure levels to be +/- 5 psi, (0,34 bar); temperature levels to be +/- 5^{0}F, +/- 2,7^{0}C
Ambient temperature between 15 to 40^{0}C 60 to 110^{0}F



6.6 Additional Tests

Any additional tests carried out under different conditions (e.g. other media, higher temperature etc.) shall be reported separately.

7. Test Procedure

7.1 Pre-Test procedure

Inspection

Measurement

Photographs

7.2 Test duration

The test duration will depend on the time used for the cool down periods of steps 4 and 8 and 12 of the temperature/pressure cycles, but a full test is expected to take three and one-half days.

7.3 Result recording

7.3.1 Leakage measurement instrumentation

A calibrated methane or helium concentration measuring instrument shall be used.

Before cycling starts take a background measurement, zero out the sensor.

Zero the sensor at the beginning of each elevated temperature cycle. Note that outgassing of the fixture or the bolt lubricant may occur during the first high temperature cycle and could result in an erroneous elevated reading.

A measurement is an average of a minimum of 10 readings over a one-minute period. Measurements should not deviate by more than 50% unless the leakage is below 10 PPM. An average of the measurements shall be recorded.

Alternatively, the differential pressure method using a reference gas volume can be used. The results are given in mass flow rate and normalized per gasket outer diameter (see Appendix D)

7.3.2 Leakage measurements

Three leakage measurements shall be conducted during phases 1, 3, 5, 7, 9, 11, and 13. They shall be taken at the beginning, middle and end of each two-hour period: 5 minutes, 60 minutes and 115 minutes, +/- 5minutes, elapsed time in the cycle.

7.4 Post-test procedure

Inspection

Measurement

Photographs

7.5 Number of tests

A minimum of 2 complete tests shall be carried out for each gasket type.

7.6 Test completion

Documentation

8. Reporting

8.1 Record all test data on a seal test report form (an example is shown in Appendix A) and graphically (an example is shown in Appendix B)

8.2 Leakage Class.

There shall be 2 leakage classes,

1) Less than 25 PPM (methane). Less than 25 ppm (Helium)

2) Less than 50 PPM. (methane). Less than 50 ppm (Helium)

1) a) 10^{-3} mg/m/s (Helium) results from AMTEC?

2) b) 10^{-2} mg/m/s (Helium)

If any reading exceeds the highest leakage class, the test shall be suspended. (No re-torque allowed).

8.4 Publishing of results

When publishing results, the average results for a minimum of two tests shall be reported and the following data must be included:

Standard reference (i.e. FSA GDxxx.2018) and Issue Number

Gasket type

Test duration

Test conditions

Leakage class achieved

Load and torque specified

8.3 The complete test report shall be made available to users on request.

Appendix A
Gasket Test report according to FSA GDXXX/2018

Test Start Date: _____. Report No: _____ .

Test End Date: _____. Performed by: _____ .

Customer: _____.

Pre-Test Information

Photographs

Description Of Gasket to be tested: _____.

Manufacturer Name / Trademark: _____.

Gasket Marking: _____.

Visual Condition of test specimen: _____.

Centering ring ☐

Outside Diameter: _____.

Thickness: _____.

Material: _____.

Inner Ring ☐

Inside Diameter: _____.

Thickness: _____.

Material: _____.

Spiral Wound Sealing Element

Outside Diameter: _____, _____, _____, _____,

Inside Diameter: _____, _____, _____, _____,

Thickness : _____, _____, _____, _____,

Winding Material: _____. Filler Material:_____.

Pre-Test information

Recommended load by the manufacturer (F) : _____ *lbs / N* Nut Friction Factor (K) : _____.

Bolt Diameter (D): _____. Bolt Torque calculated with formula T=KFD : _____ ft lbs /Nm

Test information

Cycle	*Reading 1*	*Reading 2*	*Reading 3*	*Average Leakage*	*Temperature °F/°C*	*Pressure psig/ bar gauge*	*Gap Between Flanges*
Initial	0	0	0	0.00	Ambient	600/41	
1	0	3	5	2.67	Ambient	600/41	
3	0	0	0	0.00	500/260	600/41	
5	3	3	3	3.00	Ambient	600/41	
7	3	3	3	3.00	500/260	600/41	
9	5	6	5	5.33	Ambient	600/41	
11	5	3	3	3.67	Ambient	600/41	
13	5	6	10	7.00	500/260	600/41	

Test Results

Maximum leakage through the test : 10 PPMv

Average leakage through the test : 3.9 PPMv

Leakage Class achieved during test : Class I

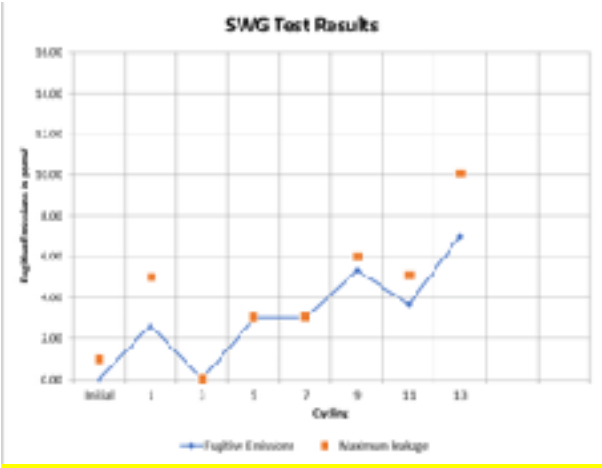
Bolt torque at end of test:_____

% Final Compression: _____

Photographs

Appendix B

Typical Graphical Representation of Results



Appendix C – Test Fixture

Assembled fixture

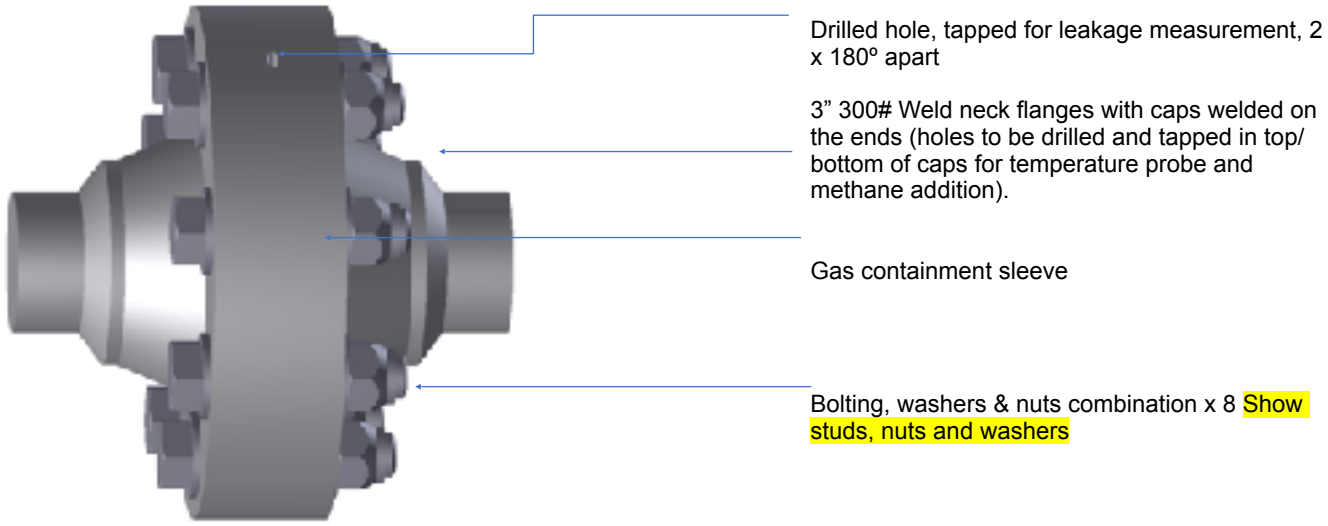


Figure 1 Typical Test Arrangement (Schematic)

Appendix C – Test Fixture

Exploded Assembly view of Fixture

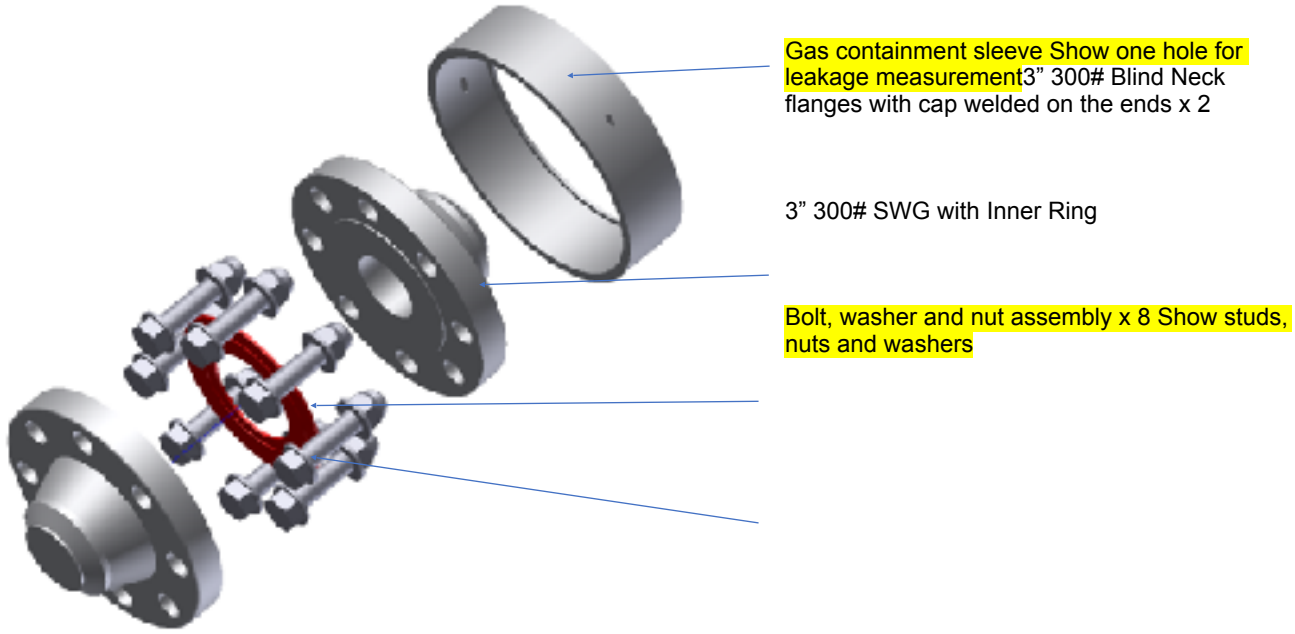


Figure 2 Typical Test Apparatus (Schematic)

APPENDIX D – Differential Pressure Method

The Differential Pressure Method consists of using two chambers of similar volume, one being the test fixture, the other being a reference leak tight chamber. The two chambers are connected to valves used for filling, venting, isolation of both chambers, and isolation between the two chambers; a differential pressure gauge is placed between the two chambers, and an absolute pressure gauge is connected to the reference chamber. See diagram in Figure 1.

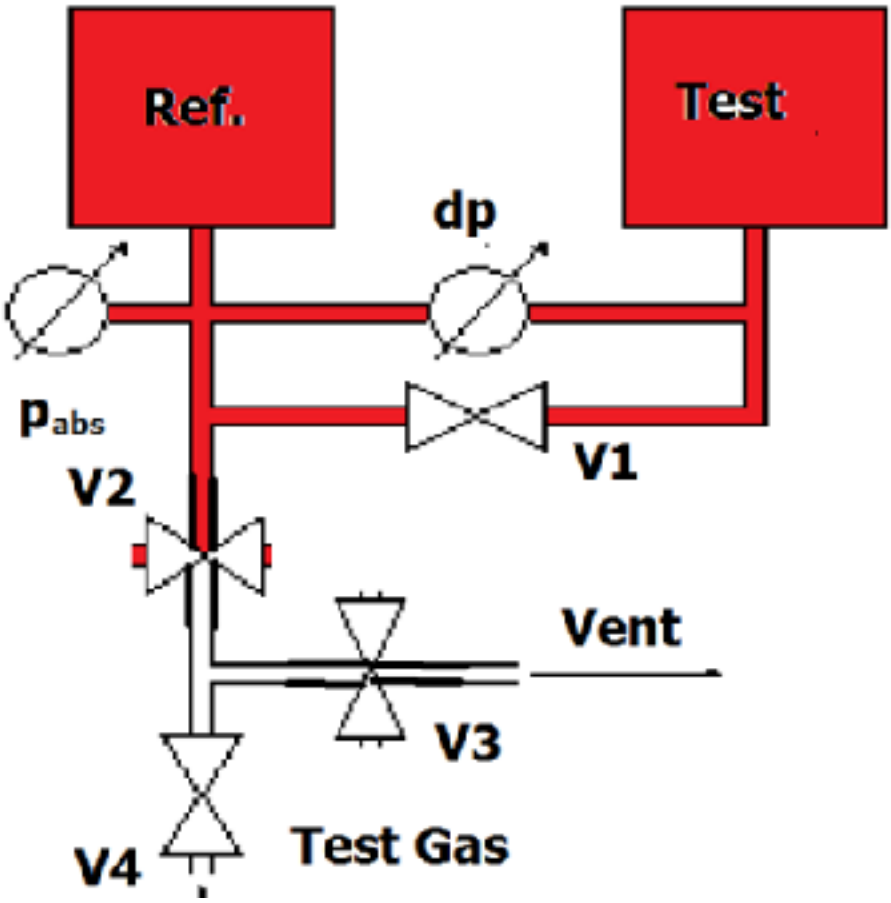


Figure 1 Schematic of Differential Pressure Method

The method consists of the following steps:

Fill the two chambers

Equalize pressure between the two chambers

Isolate the two chambers from each other

Subject the test chamber to the test conditions. (As test gas leaks out of the test volume its pressure decreases)

Measure pressure differential between the test and reference chambers over test time period

Equalize the pressure between the two chambers

Vent the system

Note: Be careful not to subject the differential pressure gauge to over pressure, such as test pressure with the reference pressure vented to atmosphere, as it would damage the instrument.

Calculations

Using the gas laws: $pV=nRT$, find $n = pV/RT$ with

p = pressure lost during the test (differential pressure, Pa)

V = Test chamber volume (m^3)

n = number of moles

R = Ideal gas constant (8.314 J/mol/K)

T = Temperature (^oK)

Convert moles to mg, (for Helium 4003 mg/mol, for methane 16040 mg/mol)

Divide by Test time (seconds)

Normalize to length (Divide by gasket mean diameter)

Results are in mg/m/s

APPENDIX E – Hydraulic Loading with Platens Test Apparatus

Image place holder – need something more generic

Need description